SP 222 Homework Chapter 28 Due MAR 2000 Name ______________________________

6 • An electron moves with a velocity of 2.75 Mm/s in the *xy* plane at an angle of 60° to the *x* axis and 30° to the *y* axis. A magnetic field of 0.85 T is in the positive *y* direction. Find the force on the electron.

14 •• A 10-cm length of wire carries a current of 4.0 A in the positive *z* direction. The force on this wire due to a magnetic field $\boldsymbol{B}$ is $\boldsymbol{F} = (-0.2\boldsymbol{i} + 0.2\boldsymbol{j})$ N. If this wire is rotated so that the current flows in the positive *x* direction, the force on the wire is $\boldsymbol{F} = 0.2\boldsymbol{k}$ N. Find the magnetic field $\boldsymbol{B}$.

17* • True or false: The magnetic force does not accelerate a particle because the force is perpendicular to the velocity of the particle.

19 • A proton moves in a circular orbit of radius 65 cm perpendicular to a uniform magnetic field of magnitude 0.75 T. (*a*) What is the period for this motion? (*b*) Find the speed of the proton. (*c*) Find the kinetic energy of the proton.

24 •• A particle of charge q and mass m has momentum $p = mv$ and kinetic energy $K = \frac{1}{2}mv^2 = p^2/2m$. If the particle moves in a circular orbit of radius r perpendicular to a uniform magnetic field B, show that (a) $p = Bqr$ and (b) $K = B^2q^2r^2/(2m)$.

25* •• A beam of particles with velocity $\vec{v}$ enters a region of uniform magnetic field $\vec{B}$ that makes a small angle θ with $\vec{v}$. Show that after a particle moves a distance $2\pi(m/qB)v\cos\theta$ measured along the direction of $\vec{B}$, the velocity of the particle is in the same direction as it was when it entered the field.

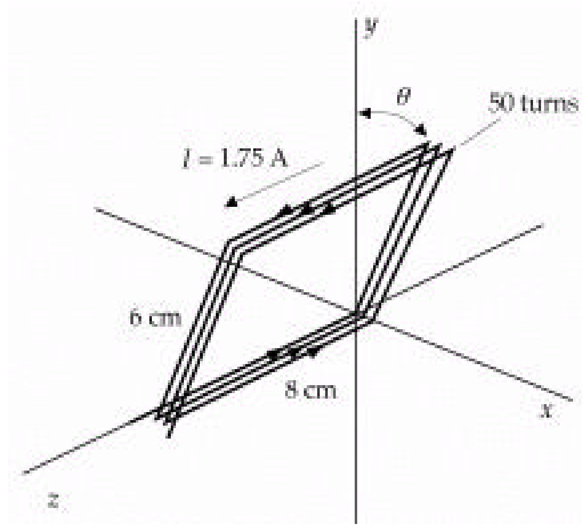
30 • A beam of protons moves along the x axis in the positive x direction with a speed of 12.4 km/s through a region of crossed fields balanced for zero deflection. (a) If there is a magnetic field of magnitude 0.85 T in the positive y direction, find the magnitude and direction of the electric field. (b) Would electrons of the same velocity be deflected by these fields? If so, in what direction?

36 •• Before entering a mass spectrometer, ions pass through a velocity selector consisting of parallel plates separated by 2.0 mm and having a potential difference of 160 V. The magnetic field between the plates is 0.42 T. The magnetic field in the mass spectrometer is 1.2 T. Find (*a*) the speed of the ions entering the mass spectrometer and (*b*) the difference in the diameters of the orbits of singly ionized ^{238}U and ^{235}U. (The mass of a ^{235}U ion is 3.903×10^{-25} kg.)

37* •• A cyclotron for accelerating protons has a magnetic field of 1.4 T and a radius of 0.7 m. (*a*) What is the cyclotron frequency? (*b*) Find the maximum energy of the protons when they emerge. (*c*) How will your answers change if deuterons, which have the same charge but twice the mass, are used instead of protons?

44 • A current-carrying wire is bent into the shape of a square of sides L = 6 cm and is placed in the xy plane. It carries a current I = 2.5 A. What is the torque on the wire if there is a uniform magnetic field of 0.3 T (*a*) in the z direction, and (*b*) in the x direction?

47 •• A rectangular, 50-turn coil has sides 6.0 and 8.0 cm long and carries a current of 1.75 A. It is oriented as shown in Figure 28-34 and pivoted about the *z* axis.



(*a*) If the wire in the *xy* plane makes an angle $\theta = 37°$ with the *y* axis as shown, what angle does the unit normal $\hat{n}$ make with the *x* axis?

(*b*) Write an expression for $\hat{n}$ in terms of the unit vectors $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$.

(*c*) What is the magnetic moment of the coil?

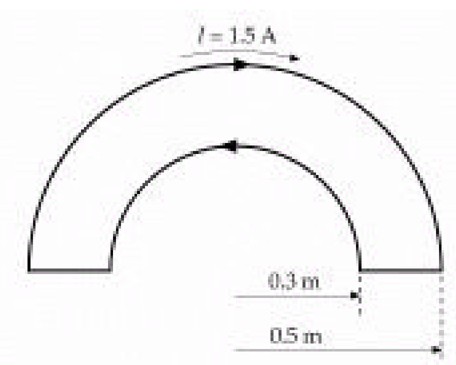
(*d*) Find the torque on the coil when there is a uniform magnetic field $\vec{B} = 1.5\ \mathrm{T}\ \hat{\mathbf{j}}$.

(*e*) Find the potential energy of the coil in this field.

48 •• The coil in Problem 47 is pivoted about the *z* axis and held at various positions in a uniform magnetic field $\vec{B}$ = 2.0 T $\hat{\mathbf{j}}$. Sketch the position of the coil and find the torque exerted when the unit normal is (*a*) $\hat{n} = \hat{\mathbf{i}}$, (*b*) $\hat{n} = \hat{\mathbf{j}}$, (*c*) $\hat{n} = -\hat{\mathbf{j}}$, and (*d*) $\hat{n} = (\hat{\mathbf{i}} + \hat{\mathbf{j}})/\sqrt{2}$.

49* • The SI unit for the magnetic moment of a current loop is A m^2. Use this to show that 1 T = 1 N/A m.

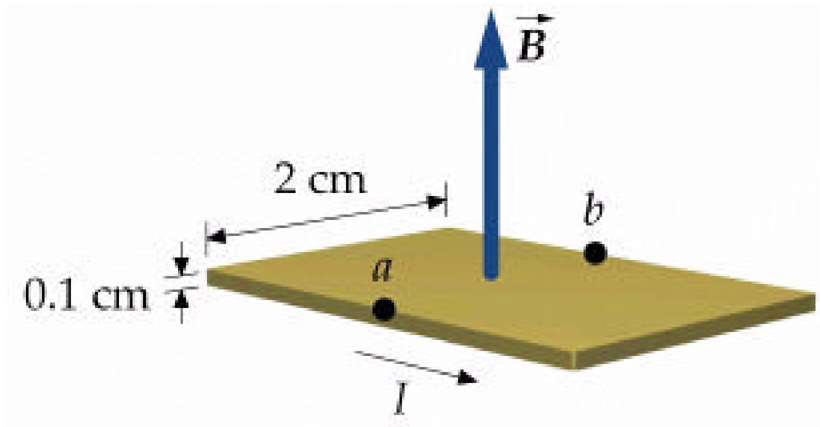
51 •• A wire loop consists of two semicircles connected by straight segments (Figure 28-35). The inner and outer radii are 0.3 and 0.5 m, respectively. A current of 1.5 A flows in this loop with the current in the outer semicircle in the clockwise direction. What is the magnetic moment of this current loop?



52 •• A wire of length L is wound into a circular coil of N loops. Show that when this coil carries a current I, its magnetic moment has the magnitude $IL^2/(4\pi N)$.

58 ••• A nonuniform, nonconducting disk of mass M, radius R, and total charge Q has a surface charge density $\sigma = \sigma_0 r/R$ and a mass per unit area $\sigma_m = (M/Q)\sigma$. The disk rotates with angular velocity ω about its axis. (*a*) Show that the magnetic moment of the disk has a magnitude $\mu = \frac{1}{5}\pi\omega\sigma_0 R^4 = \frac{3}{10}Q\omega R^2$. (*b*) Show that the magnetic moment $\vec{\mu}$ and angular momentum $\vec{L}$ are related by $\vec{\mu} = (Q/2M)\vec{L}$.

66 • A metal strip 2.0 cm wide and 0.1 cm thick carries a current of 20 A in a uniform magnetic field of 2.0 T, as shown in Figure 28-39. The Hall voltage is measured to be 4.27 μV. (*a*) Calculate the drift velocity of the electrons in the strip. (*b*) Find the number density of the charge carriers in the strip.(*c*) Is point *a* or *b* at the higher potential?



69* •• Because blood contains charged ions, moving blood develops a Hall voltage across the diameter of an artery. A large artery with a diameter of 0.85 cm has a flow speed of 0.6 m/s. If a section of this artery is in a magnetic field of 0.2 T, what is the potential difference across the diameter of the artery?

73* • True or false:

(*a*) The magnetic force on a moving charged particle is always perpendicular to the velocity of the particle.
(*b*) The torque on a magnet tends to align the magnetic moment in the direction of the magnetic field.
(*c*) A current loop in a uniform magnetic field behaves like a small magnet.
(*d*) The period of a particle moving in a circle in a magnetic field is proportional to the radius of the circle.
(*e*) The drift velocity of electrons in a wire can be determined from the Hall effect.

74 • Show that the force on a current element is the same in direction and magnitude regardless of whether positive charges, negative charges, or a mixture of positive and negative charges create the current.

75 • A proton with a charge $+e$ is moving with a speed v at 50° to the direction of a magnetic field $\vec{B}$. The component of the resulting force on the proton in the direction of $\vec{B}$ is (*a*) $evB \sin 50° \cos 50°$. (*b*) $evB \cos 50°$. (*c*) zero. (*d*) $evB \sin 50°$. (*e*) none of these.

76 • If the magnetic field vector is directed toward the north and a positively charged particle is moving toward the east, what is the direction of the magnetic force on the particle?

77* • A positively charged particle is moving northward in a magnetic field. The magnetic force on the particle is toward the northeast. What is the direction of the magnetic field? (*a*) Up (*b*) West (*c*) South (*d*) Down (*e*) This situation cannot exist.